Sci. 835:120-131 (1997), each of which is hereby incorporated by reference in its entirety).

An alternate strategy which is contemplated involves the oral delivery of peptide mimics representative of self tissue antigens displayed on the surface of polymerized nanoparticles along with an M cell targeting molecule, as described in Example 5. Similarly, DNA encoding such antigen with an M cell targeting molecule could be displayed on a nanoparticle vaccine. The processing of tolerogenic peptides or DNA encoding for such peptides (with the appropriate regulatory T cell epitope or none at all) by M cells, the synthesis of tolerogenic peptides in situ and the subsequent presentation to regulatory T cells in the Peyer's patch would lead to mucosal as well as systemic tolerance.

The various self-antigens or tolerogenic peptides that may be presented by way of an M cell directed vaccine as described above include Type II collagen (arthritis) (Weiner, et al., "Oral Tolerance and the Treatment of Rheumatoid Arthritis," *Springer Semin. Immunopathol.* 20(1-2):289-308 (1998), which is hereby incorporated by reference in its entirety), myelin protein MBP, PLP, MOG 9 (multiple sclerosis) (Hafler, et al., "Oral Administration of Myelin Induces Antigen-Specific TGF-beta 1 Secreting T Cells in Patients with Multiple Sclerosis," *Ann. N.Y. Acad. Sci.* 835:120-131 (1997), which is hereby incorporated by reference in its entirety), S—Ag, IRBP (uveitis), ArchR (Myasthenia gravis) (Sempowski, et al., "Effect of Thymectomy on Human Peripheral Blood T Cell Pools in Myasthenia Gravis," *J. Immunol.* 166:2808-2817 (2001), which is hereby incorporated by reference in its entirety), insulin, GAD (type 1 diabetes) (Bach, "Insulin-Dependent Diabetes Mellitus as an Autoimmune Disease," *Endocr. Rev.* 5(4): 516-523 (1994), which is hereby incorporated by reference in its entirety), thyroglobulin (thyroiditis), basement membrane antigen (glomerulonephritis) (Wilson, et al., *In The Kidney*, Brenner and Rector, eds. W. Saunders, Philadelphia (1991), which is hereby incorporated by reference in its entirety) or colonic proteins (colitis). Such antigen materials may be obtained by PCR with human tissue or, by decoding the displayed peptides from phage display using autoimmune antibody directed against the tissue proteins.

Example 11

Tumor Vaccines: Increasing Immunogenicity with the Use of Immunomodulatory Cytokines.

The dominant thrust of current research in tumor immunobiology has focused on defining antigens recognized by human T cells and on augmenting the cellular immune response to tumors. Consequently, the focus of these efforts has been on protein or oligopeptide tumor antigens. Recent studies have focused on the use of vaccines containing oligopeptides or peptides representative of key regions in the tumor cell epitope (Zhou, et al., "An Agonist Anti-Human CD40 Monoclonal Antibody that Induces Dendritic Cell Formation and Maturation and Inhibits Proliferation of a Myeloma Cell Line," *Hybridoma* 18(6):471-478 (1999); Kieber-Emmons, et al., "Cutting Edge: DNA Immunization with Minigenes of Carbohydrate Mimotopes Induce Functional Anti-Carbohydrate Antibody Response," *J. Immunol.* 165(2): 623-627 (2000); which are hereby incorporated by reference in their entirety).

Additionally, it has been shown that cytokines may be used as immunomodulatory adjuvants to be administered in formulations with the tumor vaccines and other vaccines described herein. For instance, liposomes incorporating interferon gamma have been shown to increase the residence time of the cytokine at the vaccination site as compared to cytokine gene transfection of tumor cells (van Slooten et al., "Liposomes Containing Interferon-Gamma as Adjuvant in Tumor Cell Vaccines," *Pharm. Res.* 17(1): 42-8 (2000), which is hereby incorporated by reference in its entirety). It is anticipated by this invention that such liposome nanoparticle vaccines could also be polymerized, which would result in further increased stability of a nanoparticle carrier and allow for an even more prolonged presence of such cytokines, improving the immune response.

Nanoparticle vaccines are contemplated which would elicit an immune response against a given cancer or tumor condition by encapsulation of a cytokine, such as interferon gamma, in a polymerized nanoparticle by the method described in Example 5. Another alternate strategy which is contemplated involves encapsulation of cytokine within a polymerized liposome nanoparticle, along with surface display of tumor specific antigens. The arrangement of such surface displayed tumor antigens could easily be optimized for the immune response desired, using techniques commonly known in the art.

Exemplary tumor specific antigens may be derived from cancers including: leukemia-lymphocytic, granulocytic, monocytic or myelocytic; Lymphomas; basal cell carcinoma; squamous cell carcinoma; breast, colon, endometrial, pancrecatic, lung, etc. carcinoma, and uterine, vaginal, prostatic, testis, ostogenic or pulmonary sarcoma (see Wang, "Human Tumor Antigens: Implications for Cancer Vaccine Development," *J. Mol. Med.* 77(9):640-655 (1999), which is hereby incorporated by reference in its entirety). Tumor antigens according to the invention include 707-AP (707 alanine proline), AFP (alpha (α)-fetoprotein), ART-4 (adenocarcinoma antigen recognized by T cells 4), BAGE (B antigen), β-catenin/m (β-catenin/mutated), Bcr-abl (breakpoint cluster region-Abelson), CAMEL (CTL-recognized antigen on melanoma), CAP-1 (carcinoembryonic antigen peptide-1), CASP-8 (caspase-8), CDC27m (cell division-cycle 27 mutated), CDK4/m (cycline-dependent kinase 4 mutated) CEA (carcinoembryonic antigen), CT (cancer/testis antigen), Cyp-B (cyclophilin B), DAM ((differentiation antigen melanoma) (the epitopes of DAM-6 and DAM-10 are equivalent, but the gene sequences are different; DAM-6 is also called MAGE-B2 and DAM-10 is also called MAGE-B1), ELF2M (elongation factor 2 mutated), ETV6-AML1 (Ets variant gene 6/acute myeloid leukemia 1 gene ETS), G250 (glycoprotein 250), GAGE (G antigen), GnT-V(N-acetylglucosaminyltransferase V), Gp100 (glycoprotein 100 kD), HAGE (helicose antigen), HER 2/neu (human epidermal receptor-2/neurological), HLA-A*0201-R170I (arginine (R) to isoleucine (I) exchange at residue 170 of the α-helix of the α-domain in the HLA-A2 gene), HPV-E7 (human papilloma virus E7), HSP70-2M (heat shock protein 70-2 mutated), HST-2 (human signet ring tumor-2), hTERT or hTRT (human telomerase reverse transcriptase), iCE (intestinal carboxyl esterase KIAA0205 (name of the gene as it appears in databases), LAGE (L antigen), LDLR/FUT (low density lipid receptor/GDP-L-fucose: β-D-galactosidase 2-α-L-fucosyltransferase), MAGE (melanoma antigen), MART-1/Melan-A (melanoma antigen recognized by T cells-1/Melanoma antigen A), MC1R (melanocortin 1 receptor), Myosin/m (myosin mutated), MUC1 (mucin 1), MUM-1, -2, -3 (melanoma ubiquitous mutated 1, 2, 3), NA88-A (NA cDNA clone of patient M88), NY-ESO-1=New York-esophageous 1), P15 (protein 15), p190 minor bcr-abl (protein of 190 KD bcr-abl), Pml/RARα (promyelocytic leukaemia/retinoic acid receptor α), PRAME (prefer-